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A PRELIMINARY STUDY OF THE SWECO VIBRO-ENERGY MILL AS A UNIT FOR FINE GRINDING

P.R.A. Andrews and G.A. Brown
Mineral Processing Laboratory

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by

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SUMMARY

The Sweco Vibro-Energy grinding mill was studied as a unit for fine grinding quartz and limestone. Initial indications are that 7.5 kg of -300 + 75 µm quartz and 7.5 kg of -600 µm limestone in separate tests can be reduced to approximately 70% by weight -5 µm in 6 h. This length of time is, however, excessive and further work is required to produce -5 µm material in more reasonable grinding times.

ÉTUDE PRÉLIMINAIRE DE LA MEULEUSE SWECO VIBRO-ENERGY EN TANT QU'APPAREIL DE BROYAGE FIN

par

P.R.A. Andrews et G.A. Brown

RÉSUMÉ

On a étudié les caractéristiques de la meuleuse Sweco Vibro-Energy en tant qu'appareil de broyage fin du quartz et de la pierre calcaire. Les premiers résultats indiquent que 7,5 kg de quartz de -300 à 75 µm et 7,5 kg de calcaire de -600 µm dans des essais distincts peuvent être broyés à 70% passant la maille de 5 µm en 6 h. Ce laps de temps est cependant excessif et des travaux additionels sont requis afin d'arriver à produire des matériaux de -5 µm dans une période de temps plus raisonnable.

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INTRODUCTION

The Vibro-Energy mill was developed by W. Podmore & Sons Ltd., Shelton, Stoke-on-Trent, England and manufactured by W. Boulton Ltd., Burslem, Stoke-on-Trent, England. Sweco, Los Angeles, California, USA is licensed by the two companies to further develop, manufacture and sell the machine.

DESCRIPTION AND PRINCIPLE OF OPERATION

This description[1] is taken from the manufacturers information. The laboratory batch grinding unit is used for wet grinding and consists of a specially designed cylindrical vessel with a double ended motor connected vertically to its bottom. Eccentric weights are attached to both ends of the shaft and the entire assembly is supported on a base by high tensile compression springs.

When the motor is switched on the upper eccentric weight causes a horizontal gyration to the vessel, while the lower eccentric weight provides a gyrating tilt to the vessel, or vertical motion. The true motion, therefore, is a vertical planetary gyration superimposed upon a horizontal planetary gyration at a frequency of 1150 cycles per minute.

MODE OF OPERATION

The vessel is charged to within a few cms of the top[1] with 11.7 mm diam. by 11.7 mm long burundum cylinders as grinding media. A slurry consisting of -300 µm (60 mesh) material to be ground plus water is charged to the mill, sufficient to fill the voids between the grinding media. The method of charging which the authors found best was to evenly distribute the dry mineral first over the surface of the grinding media and then to wash down the mineral between the grinding media with the calculated volume of water. The lid is then securely locked in position and the motor switched on. Immediately the mineral and water will vibrate down between the grinding media; after 15 min the machine is stopped to check that the mineral is completely wetted and that the slurry level should be such that the tips of the grinding media show.

Information regarding pulp density is not very concise; a range between 15 to 70% solids being quoted, depending on the physical characteristics of the material to be ground. It is suggested that minerals such as aluminium

oxide can be successfully ground at 55% solids. Similarly there is only limited information concerning grinding time and no information is available regarding size analyses of ground products.

EVALUATION STUDY

Two minerals were chosen, quartz (hardness 7) and limestone (hardness 3.5) to represent the range of hardness that is most likely to be encountered in fine grinding of industrial minerals.

The basic procedure was to grind each mineral at -600 µm and approximately 55% solids pulp density with 65.6 kg of 11.7 mm diam. by 11.7 mm long burundum cylinders for 6 h. A maximum top size of -600 µm was chosen rather than -300 µm (60 mesh) in order to assess whether the unit would grind such a coarse size. The weight of mineral plus water being based on the void space between the grinding media. After grinding, ground mineral was washed into a large container. The volume of wash water necessary to remove the ground pulp was kept to a minimum by operating the unit with the discharge valve open and washing the vibrating pebbles. Subsequently the ground pulp was wet screened at 44 µm and the +44 µm fraction, after drying, further screened using appropriate coarser sieves. The -44 µm fraction was further sized at 5 µm, 15 µm and 25 µm sizes by decantation based on Stoke's law for free falling particles. The -15 + 5 µm, -25 + 15 µm and -44 + 25 µm fractions were dried and the -5 µm calculated by difference. The cumulative % passing size analyses of each unground mineral are presented in Table 1 and the respective cumulative % passing size analyses of various grinds conducted on each mineral in Table 2.

Initially 78.4 kg of burundum cylinders were charged to the mill, sufficient to fill the vessel to within approximately 100 mm of the rim. This test (Test 1) was, however, terminated after 3 h since it appeared that there was very little grinding action taking place. Subsequently grinding media was removed until the weight of grinding media was 65.6 kg. This was the lowest weight, which together with mineral plus water, would allow the unit to be operated without bolting to the floor. It was found that with a grinding media less than 65.6 kg the unit moved across the floor when operated.

Grinding quartz and limestone with 65.6 kg of burundum cylinders was much more dynamic than with 78.4 kg.

DISCUSSION OF RESULTS

Grinding -600 µm quartz for 6 h produced 31.3% by weight of -5 µm (Test 3); by reducing the initial top size to -300 µm and removing the -75 µm portion, the amount of -5 µm was increased to 68.0% by weight (Test 8) using the same grinding time. While the pulp density was kept approximately constant for these tests, the weight of quartz was, however, reduced from 8.8 kg in Test 3 to 7.5 kg in Test 8.

Grinding 7.5 kg of -600 µm limestone for 6 h (Test 4) produced a flocculated product which could not be sized at 5 µm. A size analysis of approximately 100% -25 µm was obtained by washing the pulp through a 25 µm (500 mesh) screen. This test was repeated as Test 10 with the addition of 13.3 kg/t Na_2SiO_3 which effectively dispersed the limestone and enabled sizing to be conducted at 5 µm. The concentration of Na_2SiO_3 was based on batch settling tests and does not necessarily represent the lowest concentration able to keep ground limestone in suspension. A value of 70.4% by weight of -5 µm limestone was obtained in this test.

Higher values than these could be obtained by extending the grinding time and reducing the initial top size. Longer grinding times would involve leaving the unit unattended at night which was not considered to be safe practice. In addition, it does not seem practical to have to wait such inordinate lengths of time in order to achieve fine grinding. Reducing the initial top size of quartz to -150 µm and limestone to -300 µm might reduce the grinding time but this aspect was not investigated.

Another possibility is to reduce the weight of grinding media which in turn would involve grinding less weight of mineral. This would mean, however, firmly bolting the unit to a solid foundation.

CONCLUSION

The initial study has shown that the Sweco Vibro-Energy mill is successful as a unit for fine grinding. To be a practical method of fine grinding further study should be directed towards establishing conditions such that the grinding time can be reduced to more reasonable levels.

REFERENCE

1. Anon. "Manufacturers technical information".

Table 1 - Cumulative % passing size analyses for unground quartz and limestone

Test No.	3	4	8	10
-600 µm	100.0	87.6		87.6
-300	77.7	43.8	99.5	43.8
-210	51.3	26.7	77.8	26.7
-150	26.3	17.4	29.2	17.4
-75	6.7	11.8	2.4	11.8

Table 2 - Cumulative % passing size analyses for ground quartz and limestone

Test No.	3	4	8	10
Weight of pebbles (kg)	65.6	65.6	65.6	65.6
Mineral	quartz	limestone	quartz	limestone
Weight of mineral (kg)	8.8	7.5	7.5	7.5
Pulp density (%s)	55.7	56.0	56.0	56.0
Head size analysis (µm)	-600	-600	-300 + 75	-600
Duration of run (h)	6	6	6	6
Ground size analysis				
-300 µm	96.6			
-210	94.6			
-150	93.4			
-74	92.5			
-44	90.1		99.9	
-25	73.8	≈100.0*	92.7	99.9**
-15	57.6		82.0	94.0
-5	31.3		68.0	70.4

*Could not be sized at 5 µm due to flocculation.

**Ground with 13.3 kg/t Na_2SiO_3.